



PAVEMENT TECH NOTES
Interim
Bases and Subbases

October 28, 2003

Editors Note: The following information was extracted from the May 1990 Task Paper on Structural Roadbed Design II – Pavements, Structured On The Job Training Program, the 1993 AASHTO Guide for Design of Pavement Structures, and the July 1, 1995 edition of the Highway Design Manual, Chapter 600.

Introduction

Structural sections are usually constructed of pavement for the surface material, either asphalt or concrete, underlain by base and/or subbase materials. The subbase layer is the structural section material between the basement soil and the base course. Subbase may be a treated or untreated granular material or a layer of soil treated with a suitable admixture such as lime. It is usually a material with less stringent specification requirements than the base course for strength, plasticity, and gradation, yet is often of better quality than the basement soil. In addition to functioning as part of the structural section, it also serves the following functions:

- To prevent intrusion of fines from the basement soil into the base course.
- Minimize the damage of frost action.
- Preventing the accumulation of free water within or below the structural section.
- Providing a working table for construction equipment.

The base course is the layer immediately below the pavement or surface course. It may be located above the subbase, or if no subbase is placed, immediately above the basement soil. Base may be an untreated or treated granular material. Base may be treated with asphalt, cement-flyash, lime, or Portland cement. The specifications for base are more stringent than for subbase materials for strength, plasticity, and gradation. The major function of a base course is structural support.

The base and subbase materials are an economic and efficient way of distributing wheel loads. Although usually there is only one base and one subbase material in the structural section, there may be an added base or subbase material designed to be a highly permeable drainage layer.

The characteristics of various subbases and bases that may be used in structural sections are discussed in the following text. Generally, these subbases and bases may be used in various combinations to design the most economical structural section for the specific project. Standard structural sections are used for portland cement concrete pavement (PCCP) with optional base and subbase combinations.

Because different types of treated and untreated aggregates have different capacities for resisting the forces imposed by traffic, this factor must be considered when determining the thickness of the structural section elements. This is accomplished with gravel factors



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(G_f), which express the relative value of various materials when compared to gravel. It is important to note that the various materials must meet the specified quality requirements, such as grading, to ensure the validity of the assigned gravel factor. Gravel factors for the various types of base materials are provided in Table A.

Since pavement design is a continually evolving field, the following text is not intended to rule out new materials or procedures, which may be developed. The Materials Engineering and Testing Services (METS) may be contacted for the latest in subbase and base materials and related design considerations.

Aggregate Subbase (AS)

Aggregate subbase (AS) is normally specified as the lowest element of any structural section because it generally results in the most economical design. It may consist of more than one layer. Whenever the basement soil has an R-value of 40 or more or whenever the normal design process results in a thin layer of subbase, consideration should be given to eliminating the subbase layer and designing a thicker base. The decision is generally based on the lowest initial cost, since both designs should be structurally equal.



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Table - A
Subbases and Bases

Type of Material	Abbreviation	Gravel Factor (G_f)	Design R-Value
Aggregate Subbase	AS-Class 1	1.0	60
	AS-Class 2	1.0	50
	AS-Class 3	1.0	40
	AS-Class 4	1.0	specify
	AS-Class 5	1.0	specify
Aggregate Base	AB-Class 2	1.1	78
	AB-Class 3	1.1 ¹	specify
Asphalt Treated Permeable Base	ATPB	1.4	NA
Cement Treated Base	CTB-Class A	1.7	NA
	CTB-Class B	1.2	80
Cement Treated Permeable Base	CTPB	1.7	NA
Lean Concrete Base	LCB	1.9	NA
Lime Treated Subbase	LTS	$0.9 + \frac{UCS}{6.9}$	NA

Notes:

1. Must conform to the quality requirements of AB-Class 2.

Legend:

NA = Not Applicable

UCS = Unconfined Compressive Strength in MPa

Whenever a blanket of permeable material is required under the full width of the structural section to handle subsurface water, the permeable layer is considered as subbase in the design calculations.

Aggregate Bases (AB)

Aggregate base is usually the material immediately below the pavement or surface course. Aggregate bases are designated as Class 2 or Class 3, the difference being that



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Class 2 has standard specifications for gradation and quality while Class 3 requirements are set forth in the special provisions. Untreated aggregate bases may be used under asphalt concrete (AC) pavement when economical. When an untreated aggregate base is proposed for use with AC pavement, its use in lieu of a treated permeable base (TPB) must be justified in accordance with Highway Design Manual Index 606.3(1). It can be used below the TPB layer but its surface should be stabilized with a properly designed filter fabric or an asphalt prime coat to mitigate the intrusion of fines into the TPB.

Stabilized Bases and Subbases

Stabilized bases and subbases are materials treated with asphalt, Portland cement, a combination of portland cement and pozzolanic materials, lime, and other cementing or stabilizing agents to improve their stability and strength as load carrying elements of the structural section. The use of such materials depends on a number of variables including relative cost and availability of materials, native material types, environmental conditions, traffic projections, and established standards and practices.

Asphalt or cement may be used to improve low-quality aggregates for use as base or subbase material.

The type and amount of stabilizing agent should be developed from tests of available materials and then cost comparisons made against untreated specification aggregates.

Cement Treated Bases (CTB)

Cement treated base is a mixture of aggregate, cement, and water. The Portland cement is specified as Type II Modified with the cement ranging from 2.5 to 5 percent by mass of the dry aggregate. Cement treated base (CTB) is generally used only with asphalt pavements and is specified in two classes described as follows:

- (a) Class A CTB consists of aggregate mixed with sufficient cement to produce a base with considerable slab strength. Class A CTB is used directly under AC to provide added strength under heavy truck traffic or placed directly below a TPB.
- (b) Class B CTB consists of aggregate with an R-value of not less than 60, which is mixed with cement in an amount sufficient to raise the R-value to not less than 80.

Either Class A or Class B CTB may be used with asphalt concrete pavements to increase its load carrying capacity and durability. Due to the slab strength of Class A and the high stability of Class B, use of either is often the most economical choice over aggregate bases because less base thickness is required.

CTB can be plant-mixed or road-mixed. Plant mixing is preferred, but road-mixing is permitted when quantities are too small to make plant-mixing cost effective. Road-



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mixing should be justified in the Geotechnical Design Report or Materials Report, as applicable.

Where cohesionless sand is used as subbase under a cement-treated base, it is necessary to provide a “working table” of aggregate subbase, aggregate base, or cement treated base aggregate. This “working table” normally will be from 75 mm to 105 mm thick to provide for the proper construction of the cement-treated base. The “working table” is considered as a subbase material in the design.

Lean Concrete Base (LCB)

Lean concrete base (LCB) was developed to provide a more rigid, less erodible base than the traditional Class A CTB for use under PCCP. The use of LCB reduces the effect of pumping action and resultant step-faulting in PCCP. LCB is a concrete mixture of aggregate mixed with about one-half the cement content of conventional concrete.

The advantages of LCB as compared to CTB include:

- (a) LCB has greater long-term strength than CTB,
- (b) The same slip-form paving equipment used for placement of PCCP may be used to place the LCB,
- (c) LCB may be placed to more accurate grade tolerances, and
- (d) Most important, the LCB surface is harder and is less subject to the erosion that contributes to step-faulting created by pumping action of truck traffic on the PCCP.

Asphalt Concrete Base (ACB)

Although frequently referred to as a separate item, asphalt concrete base (ACB) is a plant-mixed dense-graded asphalt concrete that is similar to that used for the surface course, except that a coarser aggregate grading may be specified for added stability. ACB is designated as Type A or Type B, depending on the quality of the aggregate. Type A is primarily a crushed aggregate, which provides greater stability than Type B.

When used with portland cement concrete pavement, the ACB is to be placed in the thicknesses shown in Table 603.2 of the Highway Design Manual.

When used with asphalt concrete pavement (ACP), the ACB is to be considered as part of the pavement layer. The ACB will be assigned the same G_f as the remainder of the AC in the structural section.



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Treated Permeable Bases (TPB)

Treated permeable bases (TPB) are mixtures of high quality coarsely graded crushed aggregate and a binder material. The binder material may be either asphalt or portland cement. The decision to use either asphalt treated permeable base (ATPB) or cement treated permeable base (CTPB) is based primarily upon economic considerations and materials availability. The option chosen is generally the project engineer's decision. The TPB for edge drains (cement or asphalt treated) will be at the option of the contractor at the time of bid based upon construction economics and materials availability.

TPB provides a highly permeable drainage layer within the structural section. The permeable base for an edge drain system extends laterally from 0.3 m outside the edge of pavement on the high side to the outside edge of the collector trench on the low side of the structural section. The TPB layer is an integral part of the structural section and provides all or part of the strength function normally required of the base layer. The permeable layer may also extend to the limits of the embankment in fill sections and is known as daylighting of the TPB layer. Refer to Figure 606.2A of the Highway Design Manual

Lime Treated Subbase (LTS)

Some soils, when treated with lime, will form cementitious compounds resulting in a relatively high strength material. When this cementing results in an unconfined compressive strength (UCS) of 2.75 MPa or greater, as determined by California Test 373, it can provide a satisfactory, economical substitute for AS. On light duty roads, a lime treated soil may also provide a satisfactory base layer.

The gravel factor for LTS is calculated from the UCS of the treated soil measured in MPa using the formula:

$$G_f = 0.9 + \frac{UCS}{6.9}$$